A Promising Adjuvant to Detachable Coils for Cavernous Packing: Onyx

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Summary

Transvenous embolization of cavernous dural arteriovenous fistulae (CDAVFs) with Onyx has recently been reported. This study was undertaken to assess the value of Onyx in transvenous treatment of CDAVFs. We retrospectively reviewed 18 patients who underwent transvenous embolization for CDAVFs of Barrow Type D with detachable coils and Onyx at our institution over five years. Patients were divided into two groups: group A, patients who had been treated with detachable coils; group B, patients who had been treated with a combination of detachable coils and Onyx.

The approach routes, angiographic results, complications and clinical outcome were assessed for both groups.

Eighteen patients with CDAVFs of Barrow Type D were treated: nine women and nine men; mean age was 41.9 years. Eleven patients treated by 19 procedures of transvenous coiling belonged to group A. Seven patients treated by eight procedures of transvenous Onyx injection belonged to group B. The periprocedural complication rate associated with coiling for both groups was 18.2% vs 16.7% with Onyx.

The duration of the procedure in both groups was 6.77±2.49 hours vs 3.75±1.63 hours with coiling vs Onyx, and the cost of Onyx was cheaper than coils. An excellent outcome was achieved in both groups: 90.9% vs 100% (group A vs group B).

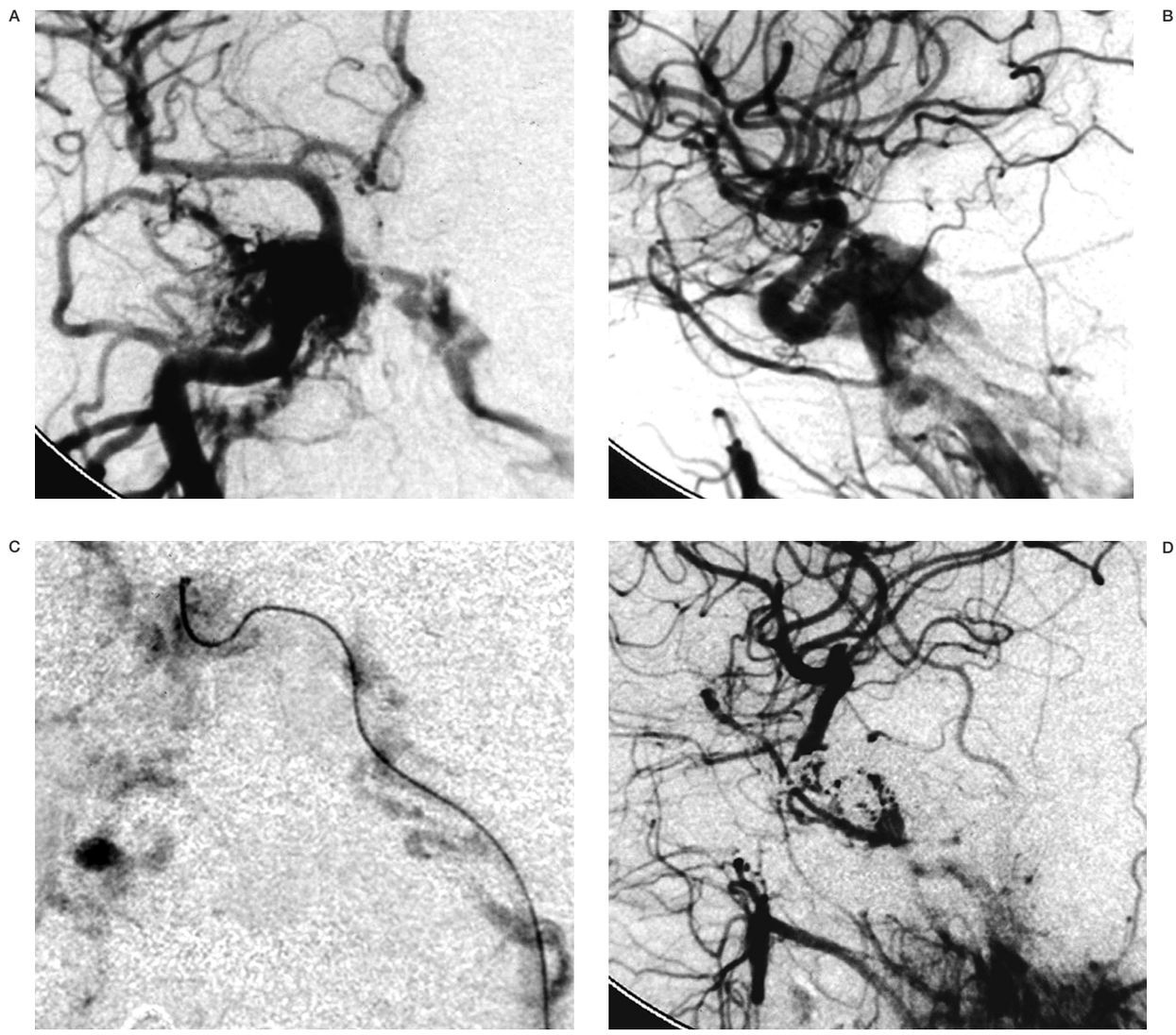
Our results associated with both modalities of CDAVFs treatment with clinical outcome show that transvenous embolization with Onyx is a safe alternative to detachable coils in the treatment of CDAVFs. However, more cases need to be evaluated.

Introduction

The goal of treatment for cavernous dural arteriovenous fistulae (CDAVF) is complete, permanent and safe occlusion of the fistula shunt. Although transvenous coiling is considered the standard for CDAVF treatment, Onyx has also been used in combination with detachable coils in a few patients with satisfactory clinical and angiographic results up to three and seven months[1,2,6,8-11,20,21]. The aim of this study was to retrospectively review our experience with these two modalities of CDAVFs of Barrow Type D, which is supplied by meningeal branches from both external and internal carotid arteries, treatment with special interest to their techniques.

Materials and Methods

Between August 2002 and December 2007, 18 patients with CDAVFs of Barrow Type D were treated at Beijing Tiantan Hospital. We retrospectively reviewed the medical reports, radiographic studies, endovascular reports, discharge sheets, and follow-up reports. There



were nine women and nine men; age ranged from 11 to 69 years (mean 41.9 years). Patients were divided into two groups: group A, 11 patients treated with detachable coils; group B, seven patients treated with a combination of detachable coils and Onyx.

Group A

CDAVF was diagnosed on the basis of cerebral digital subtraction angiography. Eleven patients were included in this group. The clinical symptoms of the patients included blurred vision (n=1), CNIII and CNVI palsy (n=4), chemosis (n=5), proptosis (n=5) and tinnitus (n=7). Five CDAVFs were supplied by the ipsilateral external carotid artery (ECA) and internal carotid artery (ICA), and seven were supplied by ECAs and ICAs bilaterally. The fistulas drained via the superior ophthalmic vein (SOV) (n=11), inferior petrosal sinus (InfPS) (n=8), superior petrosal sinus (SupPS) (n=3), and leptomeningeal vein (n=1).

Group B

Seven patients with CDAVFs of Barrow Type D were included in group B. The clinical symptoms of the patients included CNIII and CNVI palsy (n=5), chemosis (n=2), proptosis (n=2) and tinnitus (n=2). One CDAVF was supplied by the ipsilateral ECA and ICA, and six were supplied by bilateral ECAs and ICAs. The fistulae drained via the superior oph-

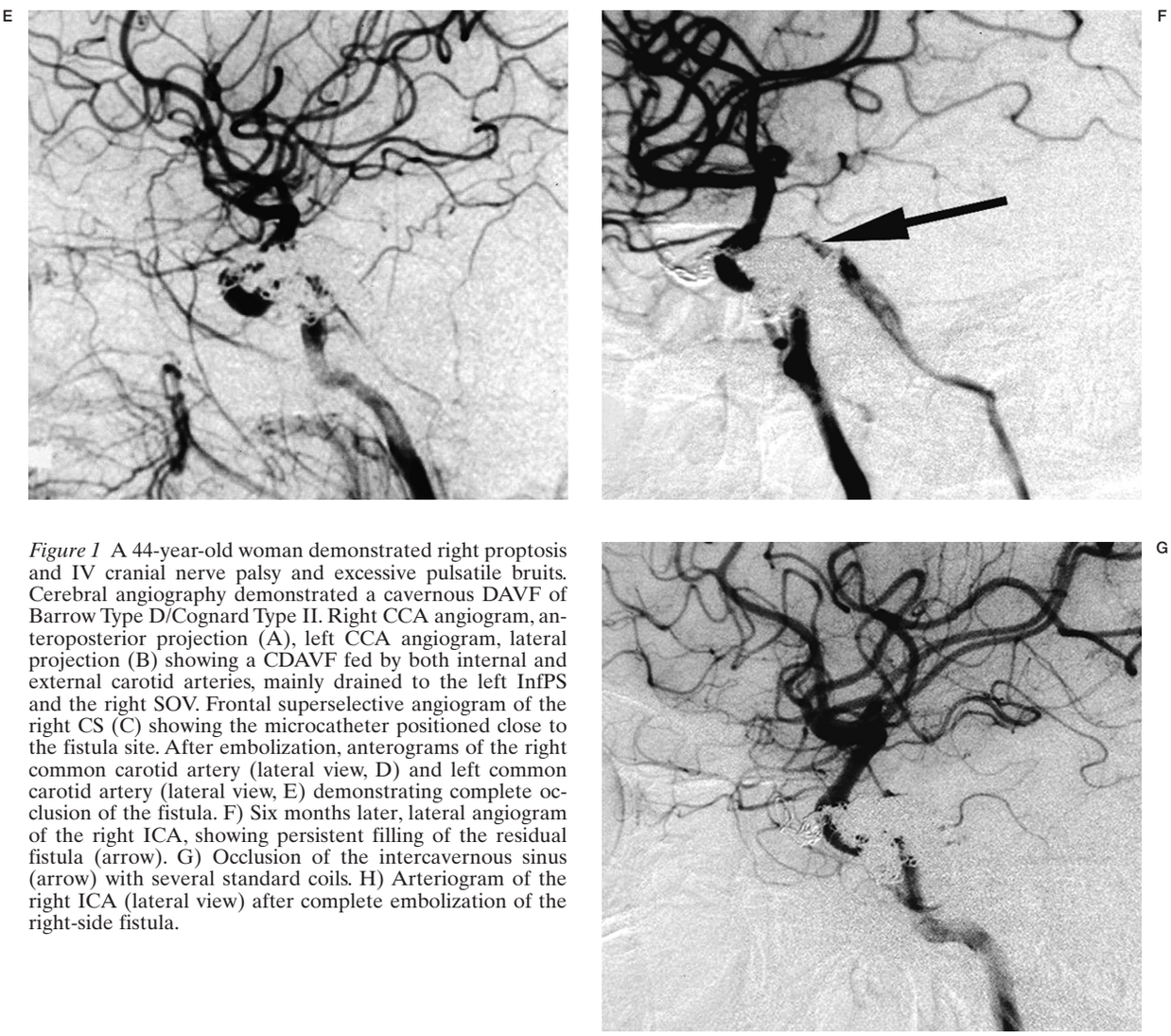


Figure 1 A 44-year-old woman demonstrated right proptosis and IV cranial nerve palsy and excessive pulsatile bruits. Cerebral angiography demonstrated a cavernous DAVF of Barrow Type D/Cognard Type II. Right CCA angiogram, anteroposterior projection (A), left CCA angiogram, lateral projection (B) showing a CDAVF fed by both internal and external carotid arteries, mainly drained to the left InfPS and the right SOV. Frontal superselective angiogram of the right CS (C) showing the microcatheter positioned close to the fistula site. After embolization, anterograms of the right common carotid artery (lateral view, D) and left common carotid artery (lateral view, E) demonstrating complete occlusion of the fistula. F) Six months later, lateral angiogram of the right ICA, showing persistent filling of the residual fistula (arrow). G) Occlusion of the intercavernous sinus (arrow) with several standard coils. H) Arteriogram of the right ICA (lateral view) after complete embolization of the right-side fistula.

thalmic vein (SOV) (n=3), and inferior petrosal sinus (InfPS) (n=5).

Treatment protocol

We first placed 6-French sheaths in the femoral artery and vein. A 5-French catheter in the carotid artery allowed observation of the shunt, acquisition of roadmaps, and angiographic monitoring of the procedure. A second 5-French catheter was positioned in the jugular vein. A microcatheter (Excelsior14, Boston Scientific, CA, USA; Echelon10/Marathon, MTI-EV3, Irvine, CA, USA) was navigated coaxially via different venous approaches. For the superior ophthalmic vein (SOV) approach, the vessel was exposed by the neurosurgeon and then

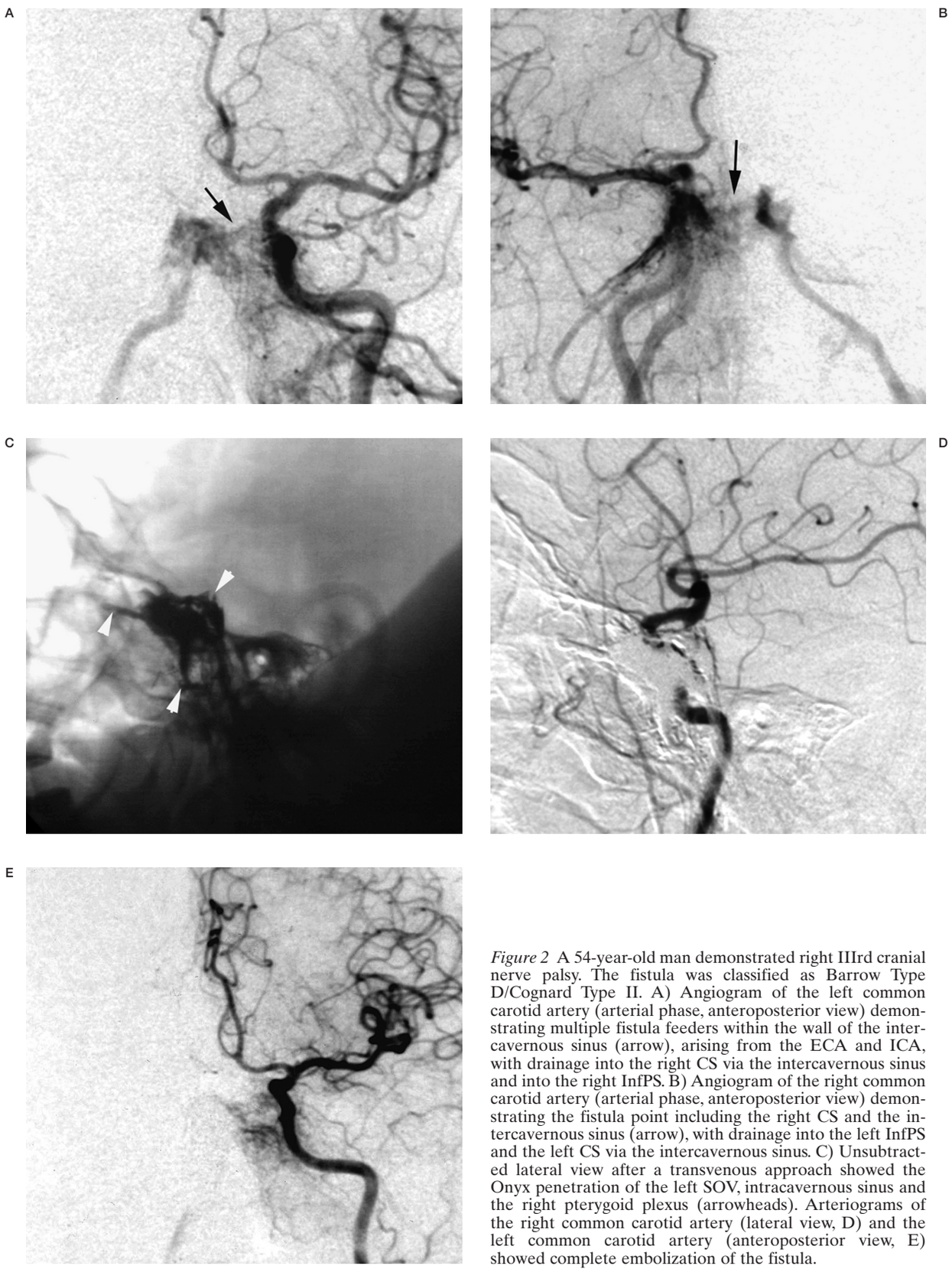


Figure 2 A 54-year-old man demonstrated right IIIrd cranial nerve palsy. The fistula was classified as Barrow Type D/Cognard Type II. A) Angiogram of the left common carotid artery (arterial phase, anteroposterior view) demonstrating multiple fistula feeders within the wall of the intercavernous sinus (arrow), arising from the ECA and ICA, with drainage into the right CS via the intercavernous sinus and into the right InfPS. B) Angiogram of the right common carotid artery (arterial phase, anteroposterior view) demonstrating the fistula point including the right CS and the intercavernous sinus (arrow), with drainage into the left InfPS and the left CS via the intercavernous sinus. C) Unsubtracted lateral view after a transvenous approach showed the Onyx penetration of the left SOV, intracavernous sinus and the right pterygoid plexus (arrowheads). Arteriograms of the right common carotid artery (lateral view, D) and the left common carotid artery (anteroposterior view, E) showed complete embolization of the fistula.

punctured. The microguidewire was then carefully introduced and advanced to the cavernous portion, followed by the microcatheter. All embolizations were performed with electrically detachable coils (Figure 1) or a combination of coils and Onyx (after August 2005, Onyx-18 and Onyx-34, group B) (Figure 2) [13,14], using real-time digital subtraction fluoroscopic mapping until angiographically complete obliteration was achieved or no more coils could be placed safely in the cavernous sinus.

Retreatment was planned in six patients treated with coiling and who showed residual shunt. This was successfully done in five patients with one failed procedure.

Clinical follow-up

The period of follow-up ranged from one to 62 months (mean 25.2 months): follow-up was done by telephone. Patient outcome was according to the following criteria: excellent (returned to the original functional level and development with no deficit), good (minor neurologic deficit that does not interfere with daily functioning or work), fair (significant neurologic deficit that interferes with daily activities or prevents return to employment), poor (coma or severe deficit rendering the patients totally dependent), and death.

Statistical analysis

Data are presented as the mean ± SD unless otherwise indicated. To compare two independent proportions, the t-test and Fisher exact test were used. The level of significance was set at $P<0.05$.

Results

Technical results

A total of 19 transvenous procedures were performed for 11 patients of group A and eight for seven patients of group B (Table1). The duration times of a procedure with coiling and Onyx, including time for general anesthesia were 6.77 ± 2.49 hours and 3.75 ± 1.63 hours (coiling vs Onyx), respectively. Of six patients treated with Onyx, two developed reflexive bradyarrythmia during DMSO injection with no morbidity. In group A, five patients with residual shunt and one with recanalization at six month follow-up were retreated. In group B, only one patient with bilateral CDAVF was treated with two procedures.

Periprocedural complications

Three (17.6%) complications were noted. Two complications were in group A and one in the group with a combination of coils and Onyx. The complications in group A were CN-VI palsy and local alopecia on the right side due to X-ray radiation; one complication of CNVI palsy was noted in seven patients treated with a combination of coils and Onyx.

Clinical outcome

Seventeen of the 18 CDAVFs (94.1%) of the cavernous sinus were cured clinically and anatomically. The resolution periods for CNIII and CNVI palsy were 6.77 ± 2.49 months vs 3.75±1.63months (coiling vs Onyx). In both groups, excellent outcome was achieved in 90.9% vs 100% (coiling vs Onyx), respectively. The initial CNVI palsy did not recover in one patient treated with coiling because of incomplete obliteration. There was no further chemosis, visual disorders or tinnitus in either group.

Statistical results

There was statistical significance in the number of procedures, duration of a treatment and resolution period of cranial nerve palsy between the two modalities of CDAVFs treatment. However, there was no statistical significance in complications, incomplete obliteration and recanalization rate or outcome between the two modalities of CDAVFs treatment.

Discussion

Today, because of frequent recanalization and low cure rates, transarterial embolization is limited to Barrow type C fistulae and Barrow Type A fistulae [12,19]. Different transvenous treatment studies revealed rates of 71 to 87.5% for anatomic cures and 83 to 96% for clinical cures[1,7,10,11,16,18,21,22]. The anatomic and clinical cure rates in our series were 94.1% for CDAVFs. Our 18 patients represent 30.4% of the patients who underwent embolization for treatment of DAVFs at our institution in the past five years. This reflects the evolution of transvenous treatment for CDAVFs at a single institution in a period of five years. the clinical and anatomic cure rates in our series were 94.4% for CDAVFs. Since the transvenous approach was introduced for embolization in 1986[11], the techniques and materials have become more effective and better tailored [2,4-11,17,18,20-22]. Transvenous

Table 1 **Clinical data of two patient groups.**

	Group A (Coiling)	**Group B (Onyx)**	**P values**
Numbers of patients	11	7	
Age (mean±SD)	11-68y (45.1±18.6)	36-69y (52.5±10.5)	
Sex (female:male)	8:3	1:6	
Barrow Type	D	D	
Feeding supplier			
Monolateral ECA and ICA	5	1	
Bilateral ECAs and ICAs	6	6	
Venous drainage			
SOV	11	4	
InfPS	8	4	
SupPS	3	0	
Leptomeningeal vein	1	0	
Treatment			
Number of procedures (mean ± SD)	19 (1.73±0.45)	8 (1.17±0.37)	t=2.605, P<0.01
Duration of a treatment (mean ± SD)	74.5 hours (6.77±2.49)	25 hours (3.75±1.63)	t=2.658, P<0.01
Incompleteness and recanalization	2 (18.2%)	0	P=0.404
Side-effects			
Bradyarrythmia	0	2	
Complications	2	1	P=0.485
CNVI palsy	1	1	
Other (alopecia)	1	0	
Resolution period of	4.5±1.7months	2.8±0.8 months	t=2.297, P<0.05
CNIII and CNVI palsy (mean ± SD)			
Clinical follow-up			
Follow-up period (mean ± SD)	35±19.8 months	7.5±4.1months	
Excellent	10 (90.9)	7 (100%)	P=0.647
Good	1	0	

R, right; L, left; F, female; M, male; SOV, superior ophthalmic vein; mo, months; InfPS, inferior petrosal sinus; FV, facial vein; SupPS, superior petrosal sinus; ICA, internal carotid artery; ECA, external carotid artery; CNIII, third cranial nerve; CNVI, sixth cranial nerve

treatment of CDAVFs was revolutionized with the introduction of electrolytically detachable coils. Since 2005, the complex nature of the fistula, the unexpected difficulty in the placement of detachable coils, and our previous experience with Onyx in the treatment of DAVFs encouraged us to use Onyx in the treatment of our patients [8,9,14,15].

Onyx-18 and Onyx-34 were used during the venous approach in our cases: Onyx-18 contains 6.0% copolymer and 94% DMSO (dimethylsulfoxide) and Onyx-34 contains 6.5% copolymer and 93.5% DMSO. Tantalum powder (35% weight/volume) is added for radiopacity. The lower the concentration of the copolymer, the less viscous the agent is and the better the penetration achieved. Onyx injection was performed into a basket of coils. In this situation, distal migration of Onyx to the ophthalmic vein can be avoided. The slow injection of the agent might have been the key factor that enabled gradual casting of the sinus, with filling of its interstices and blocking of the minute fistulous communications. During the intracavernous injection of the embolic agent caution should be exerted to avoid inadvertent embolization of the internal carotid artery.

Although a meta-analysis investigating the efficacy and safety of transvenous embolization is not available [11], we selected 18 patients with CDAVFs of Barrow Type D treated with coils and a combination of Onyx and coils to evaluate the advantages and disadvantages of Onyx in intracavernous packing. Comparing cases treated in recent years, as in this study, Onyx has shown some advantages over detachable coils. Its nonadhesive and cohesive properties make this agent suitable for transvenous casting of the cavernous sinus [2,8,9,20]. To achieve complete occlusion, two or more procedures of transvenous coiling will be performed in patients with incomplete obliteration or recanalization, Onyx injection is easier and the time for each treatment procedure is remarkably shortened and complete occlusion can be achieved in one procedure.

In our series, approximately 18.2% (2/11) of CDAVFs treated using transvenous coiling demonstrated residual fistulae, which was comparable with previous reports of 2.3% to 8.2% and as high as 42% [10,11,18,22]. Although there was a residual shunt in group B, Fisher exact test did not show statistical significance (P=0.404) between the two groups, and more cases should be evaluated. It is well known that coil embolization can cause cranial nerve palsy [1,16], in our series of Onyx embolization, a patient developed CNVI palsy after the procedure. Our procedural complication rate associated with coiling embolization (18.2%) was comparable (P=0.485) with that (16.7%) of Onyx embolization. Although reflexive bradyarrythmia occurred in our two patients treated with Onyx, atropine was shown to extinguish the TCR effectively in our patients and early detection of TCR allows for appropriate treatment [13]. Although no significantly favorable (P=0.647) clinical outcome was noted with coil embolization than with Onyx embolization in our study, we did note a significantly shorter period of cranial nerve palsy resolution in patients who underwent Onyx embolization compared with the group who underwent coiling. This may depend on the less massive effect of Onyx cast. We found the use of Onyx particularly useful for cavernous packing, with the use of adjuvant coils. For this purpose, injection is started with Onyx-34 until the fistula is closed, and injection is continued with Onyx-18 for subsequent filling of the nidus.

Conclusions

Our results associated with both modalities of CDAVFs treatment with clinical outcome show that transvenous embolization with Onyx is a safe alternative to detachable coils in the treatment of CDAVF. With the rapidly evolving technology of transvenous embolization, accumulated experience, and good selection of patients with intravenous accessibility, our retrospective study indicates that the advantages make Onyx an attractive alternative to already described platinum coils. However, more cases have to be evaluated.

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